MARYLAND DEPARTMENT OF TRANSPORTATION

STATE HIGHWAY ADMINISTRATION

RESEARCH SUMMARY

EFFECTIVELY IMPLEMENTING MACHINE LEARNING WITH OFFICE OF MATERIALS TECHNOLOGY

WHAT WAS THE NEED?

Every year MDOT invests millions of dollars into testing geomaterials, digitizing historic records and capturing infrastructure inventory and condition data. There is a significant opportunity for cost savings by leveraging historic material testing data with predicative machine learning models to provide estimated values as well as gaining a better understanding of the historical data in the MDOT SHA inventory. Improved cost effectiveness of the agency can be achieved by enhancing analysis capabilities and improving decision-making by incorporating cutting-edge machine-learning methods into planning and work processes.

WHAT WAS THE GOAL?

This Phase II research implements recent advance in machine learning methods for LiDAR DEM data based landslide risk assessment, slope/embankment detection for geotechnical asset inventory, scarp line detection, concrete compressive strength test data modeling and prediction, pavement marking retroreflectivity data modeling and deterioration condition prediction.

WHAT DID THE RESEARCH TEAM DO?

Cutting-edge machine learning models were developed and trained for the selected highway datasets including object detection in LiDAR DEM data and other raster image datasets, drilling data, geologic risk, pavement marking retro-reflectivity, concrete compressive strength

PUBLICATION MONTH, YEAR
OCTOBER 2023

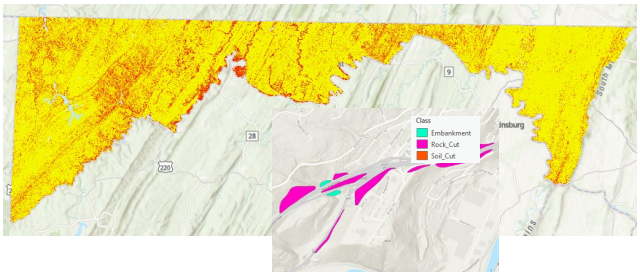
REPORT NUMBER:
MD-21-SHA/UM/6-06

START DATE:
April 28, 2021

COMPLETION DATE:
October 20, 2023

PRINCIPAL INVESTIGATOR:
Yunfeng Zhang
University of Maryland
zyf@umd.edu

test data and develop machine learning methods for these data. Tabular data neural network models for concrete strength data and pavement marking retro-reflectivity data were processed and trained for target variable prediction.



A geospatial machine learning model has been trained to assess the landslide risk in Maryland. Trained with historical slope failure data, the model was applied to statewide 2-meter resolution LiDAR DEM data to generate the landslide risk map. Locations with a risk score greater than 0.5 have been highlighted to inform engineers with increased landslide risk.

Instance segmentation machine learning models have been investigated and their prediction performance were tested for validity on automated generation of geotechnical inventory dataset including embankments and slopes as well as scarp distress lines. Automated detection of cut slope, embankment and scarps in LiDAR DEM derived slope raster data are an important step in identifying potential geologic slope instability hot spots in the state highway network.

Both regression ML model for concrete compressive strength prediction and classification ML model for out-putting confidence score of passing 28-day strength test were developed and feature importance study were performed.

Laserlux collected pavement marking retro-reflectivity data was visualized in arc gis pro and then used to train machine learning regression models that predict the retro-reflectivity values for various marking materials. The feasibility of using machine learning model predicted retro-reflectivity value for establishing pavement marking condition deterioration curve was also demonstrated.

WHAT WAS THE OUTCOME?

Cutting-edge machine learning models for identified MDOT OMT datasets have been developed to derive previous invisible relationships and trends within the historical data. These predictions will be implemented to generate more accurate preliminary designs, which will result in significant fiscal savings. These machine learning methods will also help ease delays in material testing by giving data requesters information that can be immediately utilized. Three types of machine learning algorithms were studied, including neural network model for tabular data, LiDAR DEM derived slope raster images based random forest model for landslide risk assessment, instance segmentation models for embankment polygon and scarp distress lines detection applications.

HOW WILL MDOT SHA USE THE RESULTS?

This project assisted SHA with making significant progress with the asset management of highway side slopes by analyzing readily available elevation data with machine learning methods to significantly expand slope inventory and to begin mapping landslide risk in Maryland. The landslide risk mapping

will be incorporated into the risk-based framework as a component of criticality of slopes. Highway vegetation makes visual slope condition characterization difficult, while the machine learning based analysis of ground elevation data was demonstrated to be promising solution for future planning level distress detection. Lessons learned from the development of machine learning-based models of slope scarp distresses will be used in the future development of next generation models of various types of slope instability distresses to objectively characterize the conditions of highway slopes across the state. This project supports planning efforts, improving SHA's ability to maintain resilient highways.

LEARN MORE

To view the complete report, click here.